

# *Iuiuia caeca* gen. n., sp. n., a new troglobitic planthopper in the family Kinnaridae (Hemiptera, Fulgoromorpha) from Brazil

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<http://zoobank.org/8F213373-CE75-493F-9973-503CF5B9E761>

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## Abstract

Received 10 March 2016

Accepted 5 May 2016

Published 6 June 2016

Academic editor:

Dávid Rédei

A new obligate cavernicolous (troglobitic) species in the planthopper family Kinnaridae is described from Brazil, and a new genus is established, as it could not be placed in any of the existing genera. Information on distribution and ecology is given. This is the second record of a troglobitic representative of this family from Brazil, and only the 6<sup>th</sup> cavernicolous kinnarid species worldwide.

## Key Words

Taxonomy

troglobite

trogomorphy

caves

Neotropics

## Introduction

A recent survey of limestone caves in the Iuiú municipality (Bahia state, Brazil) by a team of the Centro de estudos em Biologia Subterrânea, Federal University of Lavras, Brazil, revealed the existence of a previously unknown species belonging to the planthopper family Kinnaridae (Figs 1–2). The species displays conspicuous troglomorphic characters such as the absence of compound eyes and ocelli, reduction of tegmina and wings as well as body pigmentation, and is thus assumed to be an obligate cavernicole (troglobiont). Following the description of *Kinnapotiguara troglobia* (Hoch and Ferreira 2013, Xing et al. 2013), the new discovery represents the second record of a troglobitic kinnarid species from Brazil.

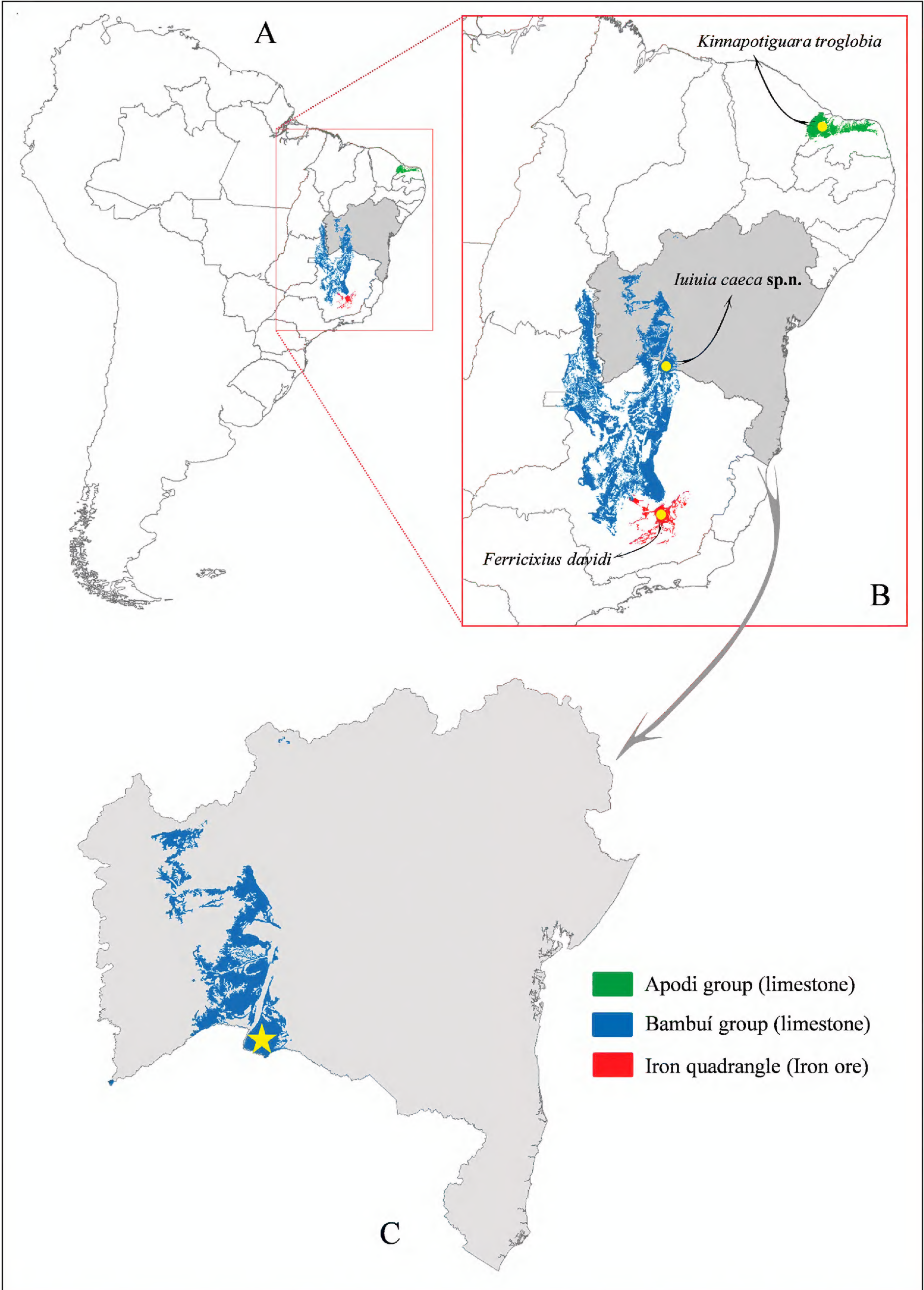
With currently 111 species in 21 genera, Kinnaridae is one of the smaller families within the Hemipteran group of Fulgoromorpha (Bourgoin 2015). Members of

the family are known to exist in the Old and New World (Bourgoin l.c.), with ca. 60 species documented to occur in the New World, predominantly in the Caribbean, North and Central America.

The epigeal Kinnaridae fauna of Brazil, like that of South America in general, must be considered virtually unknown: hitherto only a single species has been documented, *Oeclidius parallelus* Muir, 1934 from Brazil.

Although information on the biology and ecology of Kinnaridae is largely lacking, the majority of the world's species are epigeal and display well-developed compound eyes, vivid colouration of the body and tegmina, and are capable of flight. A few lineages, however, have colonized caves. Apart from *Kinnapotiguara troglobia*, described only recently from a limestone cave in Rio Grande do Norte State, NE Brazil (Hoch and Ferreira 2013, Xing et al. 2013), cave-dwelling kinnarid species have been reported from caves in Jamaica and Mexico: *Oeclidius antricola*





**Figure 1.** A Map of South America highlighting Brazilian states and three important speleological areas; **B** localities in Brazil where troglobitic planthoppers have been found; shaded area: Bahia State; **C** Bahia State, area enlarged, with limestone formations of the Bambuí group highlighted (blue).





**Figure 2.** **A** Surface vegetation near Toca do Baixão; **B** cave entrance, **C** *Iiniia caeca* sp. n., adult male, on cave floor; **D** cave interior. Photographs by R.L. Ferreira.



Fennah, 1980, and *Oeclidius minos* Fennah, 1980 (both troglobitic, Jamaica, occurring syntopic in Clarendon, Jackson Bay, Jackson Bay Cave), *Oeclidius persephone* Fennah, 1980 (not conspicuously troglomorphic, except for the red pigmentation of the compound eyes; presumably troglophilic, from Jamaica, Clarendon, Portland Ridge, Portland Cave), and *Oeclidius hades* Fennah, 1973 (troglomorphic, presumably troglobitic, from Mexico: San Luis Potosi, E. Valles, Cueva de Valdosa) (see Fennah 1973, 1980, Hoch and Ferreira 2013).

The classification of Kinnaridae is still under debate. Even Kinnaridae as a family has not yet been established as a monophyletic group. O'Brien and Wilson (1985:88) even stated that „the Kinnaridae may .... be difficult to identify“ and only Asche (1988: 51) mentioned the „comparatively broad costal field in the tegmen“ to be not only of diagnostic, but also of phylogenetic value. Bourgoïn (1993) provided an initial phylogenetic hypothesis of a close relationship of the Meenoplidae and Kinnaridae based on a cladistic analysis. According to his hypothesis, Kinnaridae and Meenoplidae together would form a monophyletic group together, while the Kinnaridae should be regarded paraphyletic. Bourgoïn (1993) considered the hypothesis as preliminary as taxon sampling was incomplete and additional character complexes needed to be examined.

Fennah (1945) subdivided Kinnaridae into the subfamilies Kinnarinae and Prosotropinae, and later provided a key to the New World genera, *Oeclidius* and *Southia* Fennah (1980).

Kinnarinae were subdivided by Emeljanov (1984) into three tribes: Kinnarini, Propleromini and Adolendini. Emeljanov (1984: 52) placed the American representatives of the subfamily Kinnarinae, namely the genera *Oeclidius* Van Duzee and *Southia* Kirkaldy, into the tribe Propleromini, limiting Kinnarini to the Old World taxa. More recently Emeljanov (2006) suggested an alternative tribal subdivision of the two subfamilies: Kinnarinae with a single tribe (Kinnarini) and Prosotropinae with four tribes (Prosotropini: New World, Kinnocciini: Old World, Oeclidiini: New World, Adolendini (= Propleromini, = Emeljanopropleromini: Koçak 1986): Old World).

Unambiguous synapomorphies have not been identified for any of the established genera or tribes. Thus the accommodation of the new species within any of the existing supraspecific taxa is inherently problematic.

Following the key provided by Emeljanov (2006) the new cavernicolous kinnarid from Brazil can be classified as a member of the subfamily Prosotropinae Fennah, 1945, and with some *caveat*, as a member of the – hitherto Old World – tribe Kinnocciini (see Discussion: tribal placement).

In characters of the male genitalia, the new cavernicolous species does not share any similarities with any species of the known kinnarid genera (in or outside Kinnocciini) which could be interpreted as synapomorphies. We thus opted for the establishment of a new genus which is described below.

## Material and methods

*Collecting, preservation, permanent storage.* The specimens were collected by hand, and transferred immediately into vials containing 96% ethanol. For permanent storage, after dissection and examination, the abdomen and genitalia were transferred to polyethylene vials, and individually associated with the specimen vial.

*Morphological examination techniques, visualization.* Measurements and examinations of external body features were made from the specimen in ethanol, without further manipulation. To prepare male genitalia for dissection, the genital capsule was removed from the specimen, macerated for 24h in 10% KOH at room temperature, washed in water, transferred to glycerine for storage, or to glycerine-jelly for drawings. Examinations and drawings were made using a Leitz stereomicroscope with a *camera lucida* attachment.

*Habitus photographs.* The photograph in Fig. 3 was obtained from an image-stack taken with the aid of a Leica MZ 16 with a camera (Canon EOS 450D) attachment and Combine ZP software, and subsequently processed with Adobe Photoshop CS3. The photograph was taken from a specimen preserved in ethanol which had to be stabilized with fine-grained sand to obtain the desired strictly dorsal view.

*Depository.* ES: Laboratório de Ecologia Subterrânea/ISLA: Coleção de Invertebrados Subterrâneos da UFLA—Universidade Federal de Lavras, Brazil.

## Taxonomy

### Kinnaridae Muir

Kinnaridae Muir, 1925: 158

Prosotropinae Fennah, 1945: 449

Kinnocciini Emeljanov, 2006: 1

### *Iuiuia* Hoch & Ferreira, gen. n.

<http://zoobank.org/431A954A-B407-4242-84D0-A2F0ED93967D>

**Type-species.** *Iuiuia caeca* sp. n. (type locality: Brazil, Bahia State, Iuiu municipality).

**Diagnosis.** Small kinnarid (ca. 3 mm body length), strongly troglomorphic: compound eyes absent, tegmina reduced, wings vestigial, body pigmentation reduced (Fig. 3). *Iuiuia* gen. n. can be distinguished from all other kinnarid genera by the unique combination of the following characters: vertex wide and short; male genitalia with genital segment in caudal aspect approximately in a figure-8-shape; anal segment short, ventrally on each side with a distinct wing-shaped compressed process; parameres slender, narrow throughout, medially converging; aedeagus tubular, stout, periandrium with two large, lateral lobes. *Iuiuia* gen. n. differs conspicuously from *Kinnapotiguara* (Hoch & Ferreira, 2013) in the configuration of the male



genitalia (Hoch and Ferreira 2013: Figs 4, 5–10): genital segment with caudal margin smooth (*vs* caudal margin with lateral processes in *Kinnapotiguara*); anal segment with two short, wing-shaped lateroventral processes (*vs* anal segment with two pairs of slender processes in *Kinnapotiguara*); parameres narrow, slender throughout, medially converging (*vs* parameres differentiated into three processes in *Kinnapotiguara*) and aedeagus with two large lateral lobes (*vs* aedeagus without lateral processes in *Kinnapotiguara*).

**Description.** Head. Vertex trapezoidal, short, ca.  $3 \times$  wider posteriorly than medially long, with a very faint median carina; anterior and posterior margin of vertex parallel. Frons narrow, ca.  $1.8\text{--}2.0 \times$  longer than maximally wide, widest between level of antennae and frontoclypeal suture, ca.  $1.3 \times$  longer than post- and anteclypeus together, surface medially smooth, devoid of a median carina, lateral margins distinctly ridged. Frontoclypeal suture nearly straight. Post- and anteclypeus with a distinct median carina. Rostrum elongate, in repose well surpassing hind coxae, third joint shorter than second. Compound eyes absent, their former position recognizable by a shallow, vaulted area. Median (frontal) ocellus absent, lateral ocelli vestigial. Antennae with scape short, subcylindrical, slightly expanding distally; pedicel subcylindrical, ca.  $2.4 \times$  as long as wide, with distinct sensory plaque organs; arista ca.  $2.8 \times$  as long as pedicel.

Thorax. Pronotum tricarinate, ca.  $3 \times$  wider than vertex posteriorly, short, posterior margin medially shallowly concave; carinae distinct, median carina attaining but not surpassing anterior margin of pronotum; lateral carinae medially more or less parallel to posterior margin, and joining posterior margin laterally. Mesonotum faintly tricarinate, ca.  $1.3 \times$  wider than medially long. Tegulae vestigial. Hind tibiae laterally unarmed, distally with 7 slender teeth, arranged in a shallow arc. First metatarsal joint distally with 4/5 and 5/6, 2nd metatarsal joint with 3/4 or 4/5 teeth (individually and bilaterally variable). Pretarsal claws and arolia small, inconspicuous. Tegmina (Fig. 4) comparatively short, very shallowly tectiform, almost flat, in repose, in males either slightly shorter than tip of abdomen (parameres), or just reaching tip of abdomen, or slightly surpassing it; in females slightly shorter than tip of abdomen (dorsal margin of gonocoxae VIII); venation in proximal portion as in epigean Kinnaridae with a large and wide subcostal cell; clavus cixioid (*sensu* Emeljanov 1984), i.e., common claval vein (Pcu and A<sub>1</sub>) reaching hind margin of clavus (vein A<sub>2</sub>); basal cell of forewing closed by anastomosis of M and CuA, without conspicuous arculus; tegmen distally of nodal line distinctly reduced and variable among specimens with 6 distal marginal cells, partly incompletely delimited due to reduced distal marginal veins. Hind wings vestigial, very short, venation strongly reduced.

Male genitalia. Genital segment bilaterally symmetrical, in lateral aspect short, ca.  $3 \times$  as high as medially long; in caudal aspect approximately figure-8-shaped, in upper third laterally constricted, with a narrow transver-

sal bridge; anterior margin of genital segment smooth, without any conspicuous median apodemes; medioventral process prominent, broadly subtriangular, in lateral aspect distinctly exceeding caudal margin. Anal segment bilaterally symmetrical, short, stout, ventrally on each side with a compressed wing-shaped process. Parameres slender, narrow throughout, medially converging. Connective straight, narrow, almost terete.

Aedeagus bilaterally symmetrical, tubular, stout; periandrium with two large lateral lobes; proximal apodeme of aedeagus (= „tectiform structure“: term applied by Bourgoin 1997 for Meenoplidae) slender, with dorsal and ventral margins rapidly diverging, proximal margin rounded.

Females with abdominal tergites VI, VII and VIII bearing wax-fields. Female genitalia as in other Kinnaridae of the non-piercing type; sternite VII broadly rectangular, caudal margin straight; caudal margin of sternite VIII medially deeply incised; gonocoxae VIII bilobate, both lobes well developed, apically converging.

**Etymology.** The genus name refers to Iuiú, the name of the municipality where the cave (type locality) is situated. The gender is feminine.

### *Iuiuia caeca* Hoch & Ferreira, sp. n.

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Figs 3–6

**Diagnosis.** Habitus (Fig. 3). Strongly troglomorphic species, predominantly yellowish body pigmentation, compound eyes and ocelli absent, dorsoventrally compressed body shape, tegmina short, in repose slightly surpassing tip of abdomen, wings vestigial.

**Description.** Body length. Measurements refer to distance between anterior margin of head to tip of abdomen (= caudal margin of parameres), those in brackets to distance of anterior margin of head to distal margin of tegmina.

Males.  $2.8\text{--}3.8\text{ (3.4--3.8)}$  mm ( $n = 8$ ). Females.  $4.4\text{--}4.5\text{ (4.0--4.1)}$  mm ( $n = 2$ ).

Colouration. Frons, vertex, pronotum yellowish, carinae contrasting dark brown; mesonotum more or less uniformly sordid yellowish; antennae and tegulae sordid light brown; tegmina translucent, uniformly yellowish-brown, veins slightly darker, without any conspicuous pattern. Metanotum, legs, as well as abdominal tergites and sternites pale yellow.

Configuration, shape and proportions of head and thorax as described for the genus.

Male genitalia (Fig. 5). Genital segment as described for the genus. Anal segment bilaterally symmetrical, short, in dorsal aspect subquadrangular, ventrally on each side with a wing-shaped, compressed lobe which is caudally rounded, cephally subacute and ventrally slightly curved medially. Parameres slender, medially concave, distally curved dorsomedially. Aedeagus bilaterally symmetrical, stout, tubular, central portion of periandrium distinctly constricted at ca. half its length, distally on its ventral side rapidly tapering into a helmet-shaped, bilobal



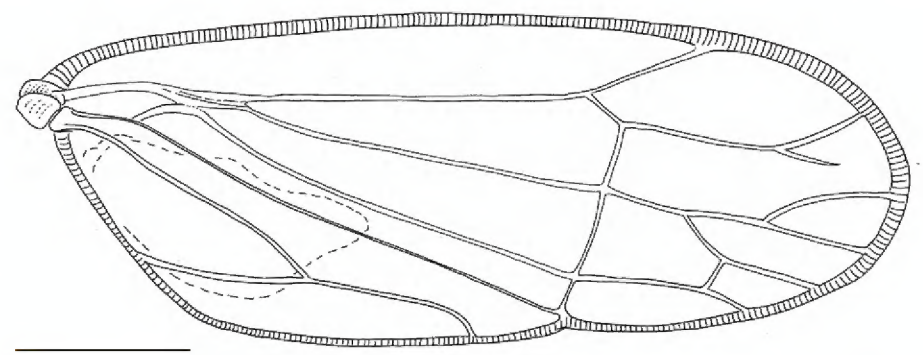


**Figure 3.** *Iuiuia caeca* sp. n. Habitus, male (holotype). Body length (apex of head to tip of abdomen) 2.8 mm. Photograph by M. Uhlig, Berlin.

structure with phallotreme apically; phallotreme in repose exposed dorsocaudally; periandrium smooth, without any spinose processes, but with two large lateral lobes which are ventrally broadly rounded, and dorsally – in their basal half – deeply concave.

External female genitalia (Fig. 6). Sternite VII in ventral aspect broadly rectangular, ca. 2.5 times as wide as long, lateral margins straight, more or less parallel, caudal margin smooth, more or less straight; sternite VIII in ventral aspect stout, in anterior portion ca. 3 times as wide as long, caudal margin medially deeply incised cephally; gonocoxae VIII bilobate: ventral lobe in lateral aspect tongue-shaped and apically rounded, dorsal lobe more strongly developed than ventral lobe, distally tapering into an acute tip pointing medioventrally; both lobes beset with setae. Tergite IX narrow, dorsally short, laterally slightly expanding caudally. Anal segment (segment X) in dorsal aspect proximally narrow, distally expanding laterally, caudal margin in ventral aspect deeply concave. Anal style (segment XI) comparatively large, paraproct narrow, elongate, epiproct rounded, caudally not surpassing paraproct.

**Distribution.** The species is only known from the “Lapa do Baixão” cave in Iuiú municipality, Bahia State, Brazil. The external vegetation in the area corresponds to the “Caatinga” formation, the only xeric biome of the country, with xeromorph, decidual vegetation (Fig. 2A). The cave has not been completely explored, since part of its inner chambers become flooded during rainy periods.



**Figure 4.** *Iuiuia caeca* sp. n. Left tegmen, male (paratype). Scale bar 0.1 mm.

However, the known passages extend over 500 meters. The only known entrance is a small opening (around 1m<sup>2</sup> – Fig. 2B), which clearly imposes a huge stability to the cave atmosphere. During different surveys in the Iuiú municipality, another eight caves located near Lapa do Baixão cave were also sampled, but no specimen of *Iuiuia caeca* was found. This strongly suggests that the species is endemic to this cave. Furthermore, this cave was visited five times, and specimens we only found during two visits, which may suggest the low abundance of the species. However, during our last visit to the cave on 9.vii.2014, several adults and nymphs were observed, though they were restricted to a small part of the cave (see “Ecology”).

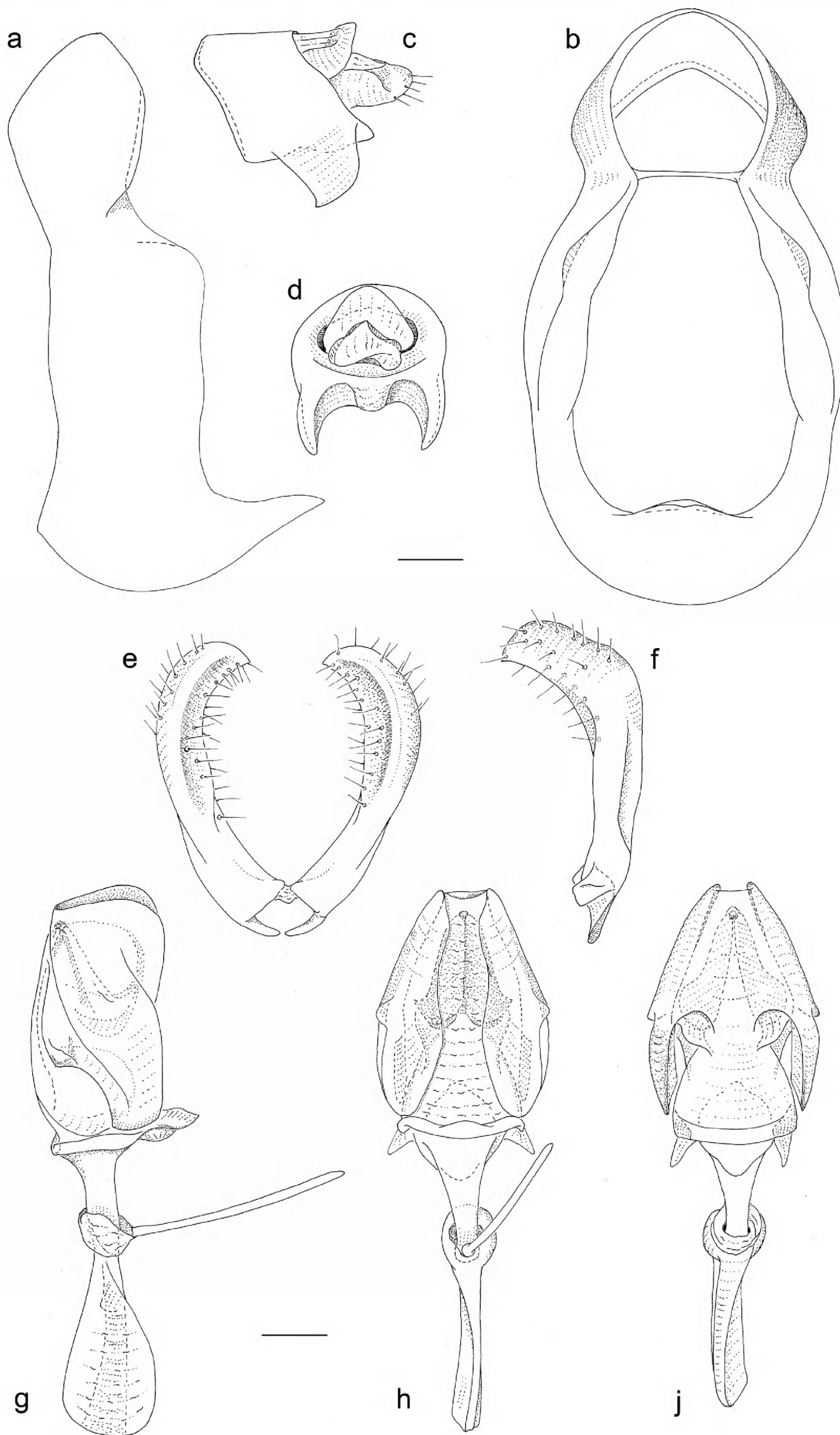
**Geology.** The “Lapa do Baixão” cave formed within limestones from the “Bambu” geological group, from the Neoproterozoic, with ages ranging from 650-850 Myr. This group comprises the largest limestone formation in Brazil, embracing most of the known Brazilian limestone caves (Fig. 1). The other two troglobitic planthoppers described from Brazil are *Kinnapotiguara troglobia* (Hoch & Ferreira, 2013) (Kinnaridae), from limestone caves from the “Apodi” group (Rio Grande do Norte state), and *Ferricixius davidi* (Hoch and Ferreira 2012) (Cixiidae), known from a single iron ore cave in the “Iron quadrangle” formation (Minas Gerais state) (Fig. 1). The Apodi group comprises limestones from the Cretaceous (around 100 Myr), while the “Iron quadrangle” is much older (around 2.4 Byr).

**Ecology.** The Baixão cave possesses dozens of roots, mainly observed in the first portion of the cave (Fig. 2D). This part of the cave adjacent to the entrance comprises a labyrinth-like system of interconnected passages; then narrows into a single vadose and semi-meandrine passage. This deep vadose passage lacks roots, and no specimens of *Iuiuia caeca* were observed there.

Unfortunately, it was not possible to associate the roots to any particular plant species in the surface vegetation, but considering the distance between the surface and the cave, it appears likely that such roots belong to substantial trees with pivotant roots systems, capable of penetrating deep inside the cracks into the soil and rock until reaching the cave chambers.

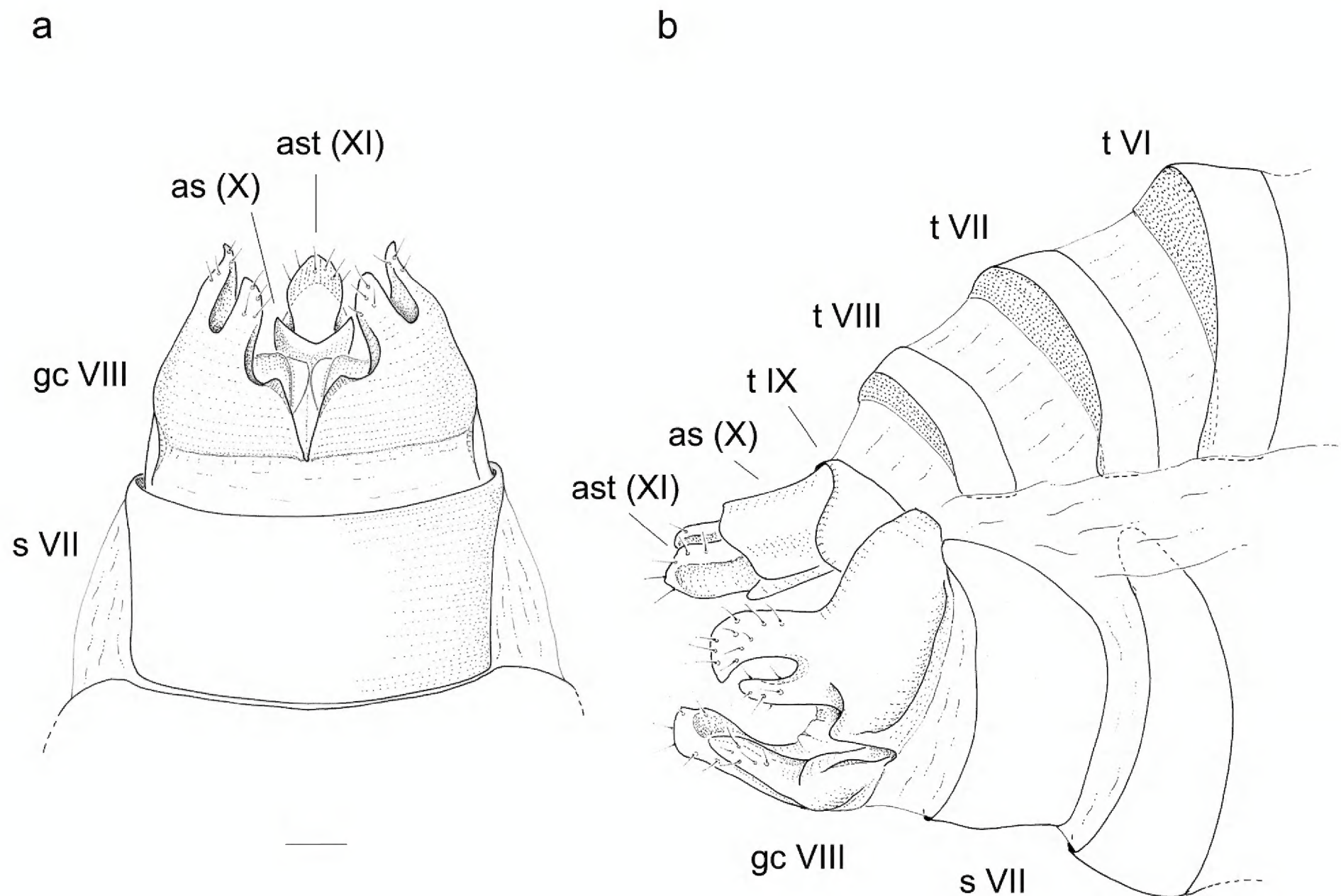
Such roots shelter a variety of invertebrate species which feed especially in their decomposing parts. However, also many non-troglomorphic Cixiidae (*Pintalia* spp.)





**Figure 5.** *Iuiuia caeca* sp. n. Male genitalia (paratype). **a** genital segment, left lateral aspect; **b** same, caudal aspect; **c** anal segment, left lateral aspect; **d** same, caudal aspect; **e** parameres, caudal aspect; **f** left paramere, left lateral aspect; **g** aedeagus with connective, left lateral aspect; **h** same, ventral aspect; **i** same, dorsal aspect; **j** same, ventral aspect. Scale bars: 0.1 mm.





**Figure 6.** Female abdomen and external genitalia. **a** ventral aspect, **b** right ventrolateral aspect. Abbreviations: s VII = VII. sternite, gc VIII = gonocoxae VIII; as (X) = anal segment (X. segment); ast (XI) = anal style (XI. segment); t VI, t VII, t VIII = tergites of segments VI-VIII. Scale bar 0.1 mm.

feed on them, especially in those roots located nearer the entrance (but also in aphotic zones). These are supposedly accidentals to the cave, but eventually can become troglaphiles. Specimens of *Iuiuia caeca* were observed only on roots within the labyrinthic part in the deep cave zone.

They were only rarely observed on the same roots where the non-troglobitic Cixiidae occur. The root mats where *Iuiuia* occur are mainly placed in the final portion of this labyrinthic part of the cave, near the connection with the inner single vadose and semi-meandrine passage. Such root mats are considerably smaller than those found in other parts of the cave. During a visit to the cave on 7.viii.2013, most of the observed specimens were nymphs, and only three adult males were found. During this visit, one of the males was found on a small root, near the cave floor, while the other two were found in an upper chamber, without roots, where they were freely walking on speleothems. During our last visit to the cave (9.vii.2014), seven adults and many nymphs were observed, but their spatial distribution was even more restricted. All observed specimens were associated with roots in a single part of the conduit, and no specimens were found in other chambers, as in the previous visit. Since both visits occurred in the dry period of the area, such differences observed on their abundance and distri-

bution cannot be primarily related to seasonal changes. Potential predators include spiders (especially Ochyroceratidae), Amblypygi (*Charinus iuiu* Vasconcelos & Ferreira, 2016) and a relatively large troglobitic pseudoscorpion species, with a body size of around 5 mm (*Spelaeobochica iuiu* Ratton, Mahnert & Ferreira, 2012); the latter is well distributed throughout the cave, but less common in the areas where *I. caeca* occurs.

**Etymology.** The species epithet “*caeca*” (blind, Lat.) refers to the complete reduction of compound eyes in this species. The gender is feminine.

**Material examined.** Holotype male. Brazil. Bahia State, Iuiu municipality, Toca Lapa do Baixão (14°23'8.13"S, 43°37'35.06"W), 7.viii.2013, R.L. Ferreira leg., in coll. Universidade Federal de Lavras, ISLA.

Paratypes: 2 males, same data as holotype. 5 males, 2 females, same data as holotype, except 9.vii. 2014, in coll. Universidade Federal de Lavras, ISLA.

**Remarks.** In the cave, several 4th and 5th instar nymphs of Kinnaridae were collected which, due to substantial morphological differences, apparently represent two species. However, none of these nymphs could be associated with certainty to *Iuiuia caeca*. Thus it is likely that the cave Toca Lapa do Baixão houses at least two, if not three, kinnarid species.



## Discussion

### Tribal placement

The placement of *Iuiuia* into Kinnocciini ought to be considered preliminary as the characters observed in *Iuiuia caeca* do not fully coincide with those given by Emeljanov (2006) in support of his tribal concept. According to Emeljanov (2006), the Kinnocciini are characterized by the combination of the following characters: 1) metope (= frons) with complete or incomplete median carina, comparatively broad, its lateral carinae of moderate height; 2) integument dull, shagreened; 3) basal cell of fore wing closed by anastomosis of M and CuA; 4) wax-field in female on abdominal segments VI, VII and VIII. While *Iuiuia caeca* displays characters 3 and 4, there is a discrepancy in characters 1–2: the frons is smooth, without any median carina, and the integument is unpigmented. These characters, however, are often observed in obligately cavernicolous planthoppers (e.g., Hoch 1994, 2002, Howarth and Hoch 2005) and are likely to be the result of parallel evolution during adaptation to cave environments. The loss of compound eyes following the colonization of subterranean habitats is usually correlated with a broadening of the head, along with reduction of carinae (e.g., Hoch and Howarth 1989a, b), and bodily pigmentation is reduced, apparently due to altered physical properties in high humidity environments (e.g., Howarth 1983).

Thus it cannot be excluded that the closest epigean relative (whether extant yet unknown or extinct) displayed a median carinae of the frons and a darkly pigmented integument.

The genera currently featured in Kinnocciini, *Kinnoccia* Remane, 1985 and *Kinnocana* Remane, 1985 (as listed in Emeljanov 2006: 77) are distributed in the Old World, and endemic to the Canary Islands (Remane 1985). Placing *Iuiuia* into the Kinnocciini would extend the distribution of the tribe to the New World, and imply a biogeographical connection which may or may not reflect the evolutionary history of the taxon.

### Epigean relatives

No close epigean relatives could be identified for *Iuiuia caeca* in Brazil, or elsewhere. The only epigean kinnarid species documented from Brazil is *Oeclidius parallelus* Muir, 1934, described from a single female from „Bahia; Iguassú“ (Muir 1934: 581), however, there is no indication of a closer relationship between *O. parallelus* and *I. caeca*. The similarity in external characters between *Iuiuia caeca* and the other troglobitic kinnarid from Brazil, *Kinnapotiguara troglobia* (Hoch & Ferreira, 2013) concerns troglomorphies and is thus the result of parallel evolution—the configuration of the male genitalia differs profoundly between the two species and does not support the assumption of a closer relationship and/or indicate a common ancestor.

### The cave planthopper fauna of Brazil: evolutionary implications

It is certainly difficult to formulate a well-supported hypothesis regarding the evolution of the subterranean lineages of the Brazilian planthoppers, mainly due to the lack of knowledge on the epigean Fulgoromorpha fauna of Brazil. Different scenarios are conceivable, and may not be mutually exclusive. Initial cave adaptation may have occurred as a consequence of allopatric speciation following the extinction of epigean ancestral species as was postulated in the climatic relict hypothesis (Vandel 1964, Barr 1968) or may be the result of parapatric speciation by an adaptive shift of troglomorphic populations to subterranean environments in order to exploit novel food resources (as suggested by Howarth 1981). For none of the cave planthoppers of Brazil, could close epigean ancestors be identified. They may not be known, or may even be extinct. Thus, all three known obligate cavernicolous planthopper species from Brazil must currently be regarded as relict species.

However, the structure and age of the rocks housing cave environments seem to be important factors acting on the evolution or at least on the distribution pattern of the cavernicolous Kinnaridae and Cixiidae of Brazil. Three biogeographic-geological constellations are observed:

1. *Iuiuia caeca* appears to be restricted to a single cave, which consists of a deep cave, which is possibly not connected to a larger system of mesocaverns.
2. Populations of the kinnarid *Kinnapotiguara troglobia* are known from many caves in the Apodi group in the Rio Grande do Norte State (Hoch and Ferreira 2013). The species is associated with shallow caves which appear to be interconnected by several mesocaverns consisting of cracks and faults (Hoch and Ferreira 2013). This might explain the wide distribution of this species. Further research must show, however, whether differentiation (genetic or behavioral although not—yet—morphological) occurs between these populations.
3. *Ferricixius davidi*, the only troglobitic Cixiidae known for Brazil, is found in a single iron ore cave, located in an area where hundreds of caves are known. This cave is very close to the surface, and roots penetrate into the subterranean macrocaverns. The cave is also interconnected with other caves in the surroundings by small canaliculi present on the topmost ferruginous breccia, which would theoretically allow migration between caves, so long as a suitable microhabitat (e.g., high relative humidity, food resources) is maintained.

### Conservation status

The external area surrounding the cave is heavily impacted, mainly by human activities such as agriculture and extensive breeding of cattle and goats. Moreover, the area is currently being evaluated for its potential for limestone extraction. Hence, although there are no mining activities yet in the area, such activities will probably start in a near future, posing a potential risk to the cave environment. A



new railway (FIOL–Ferrovia de Integração Oeste-Leste) that is being constructed connecting the Brazilian coastal area to this inner portion of Bahia state will favour the outflow of feedstock (especially agricultural products and ore), which will certainly contribute to arising the interest of exploiting the limestone in the area. Fortunately, the cave did not show any indication of human visitation, thus we consider the best option for the moment in order to preserve the cave may be to not publicly disclose the precise GPS data of its location.

It is worth mentioning that the Lapa do Baixão cave has many other troglobitic species (12 species) from which only two are currently described: *Spelaeobochica iuiu* Ratton, Mahnert & Ferreira, 2012 (Pseudoscorpiones, Bochiidae) and *Iuiuniscus iuiuensis* Souza, Ferreira & Senna, 2015 (Isopoda, Stytoniscidae). Therefore, *Iuiuia caeca* comprises the third troglobitic species described from this cave, which certainly deserves attention regarding its conservation. Many hotspots of subterranean biodiversity (those caves or cave systems with 20 or more cave obligate species) (Culver and Sket 2010) occurs around the world, but currently there are no such hotspots in South America. In most cases, the high number of troglobitic/stygobitic species depends on the sampling efforts spent in a given cave.

Accordingly, Toca do Baixão cave certainly has potential to become a hotspot in the future, since only a few samplings were conducted there. Therefore, it is crucial that Brazilian government earmark some conservation efforts to preserve this unique cave and its endemic inhabitants.

### Brazil – hotspot of cave planthopper diversity?

The discovery of *Iuiuia caeca* not only represents the 3rd obligate cavernicolous Fulgoromorpha species in Brazil, but also provides evidence of three separate evolutionary lineages which have invaded caves, two within the Kinnaridae, and one within the Cixiidae. All three species were discovered within a few years and are the result of the exploration efforts of a single, but active team of speleologists. Given the vast extension of cavernous substrate in Brazil and the availability of suitable planthopper habitat, Brazil may soon join Hawaii (e.g., Fennah 1973a, Hoch and Howarth 1999, Wessel et al. 2013), Australia (e.g., Fennah 1973b, Hoch and Howarth 1989a, b, Hoch 1990, 1993) and the Canary Islands (e.g., Remane and Hoch 1988, Hoch and Asche 1993, Hoch et al. 2012) as another hotspot for cave planthopper diversity. It is to be hoped that legal measures for the conservation of the subterranean fauna of Brazil—which constitutes one of the country's unique biological resources—will be developed and consequently reinforced.

### Acknowledgements

We would like to express our sincere thanks to our colleagues Marconi Souza Silva (UFLA) and Luiz Felipe Moretti Iniesta for helping with collections, and to our

colleagues at the Museum für Naturkunde, Berlin: Manfred Uhlig for the male habitus photograph (Fig. 3), Andreas Wessel for assistance in the layout of figures, and Jason Dunlop for language editing. Alexandr Emeljanov, Zoological Institute, Russian Academy of Science, St Petersburg, and Manfred Asche, Museum für Naturkunde, Berlin, gave valuable taxonomic advice and provided constructive comments on the manuscript. The work on which this manuscript is based was funded by the Conselho Nacional de Pesquisa (CNPq), process nº 477712/2006-1, and to R.L.F. (CNPq grant nr. 304682/2014-4).

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